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Annosus Root Rot in Eastern Pines

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The fungus *Fomes annosus* causes a root and butt rot of conifers in many temperate parts of the world. Annosus root rot damage now appears to be increasing in the Eastern United States, especially in planted forests following thinning. In some areas, losses are already heavy, and with large acreages of plantations now reaching thinning age, this disease is causing increasing concern among foresters.

Distribution

Fomes annosus is prevalent throughout the North Temperate Zone and has also been found in some tropical and subtropical areas. The fungus is native to this country and can be found wherever conifers are grown. Killing by annosus root rot has been reported in most eastern States.

A survey in 1961, covering the East and South, showed that annosus root rot damage occurred in some thinned pine plantations throughout the entire area, although the pine species surveyed in the South were different from those examined in the Northeast. The incidence of annosus root rot was higher in the coastal states from Virginia through Texas than in the Northeast. Within this southern region, however, there was much variation in damage between specific areas, from localities several counties in extent with almost no damage to others with consistently high losses. In general, the results showed that the Southeast had the highest incidence of disease of any area surveyed.

Hosts

In the East, annosus root rot has been found killing loblolly, longleaf, sand, pond, pitch, red, slash, shortleaf, Virginia, and white pines. The fungus attacks many other conifers and is a major cause of death of eastern redcedar. Most of our native conifers are probably susceptible to infection under some conditions, but their relative susceptibility is not yet known. Slash and loblolly, the most commonly planted species of southern pines, are very susceptible to the disease.

The disease has been reported on several hardwood species in Europe, but in general, deciduous trees are much more resistant

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Figure 1.—Conk of *Fomes annosus* at ground line of dying pine.

than conifers. There have been no reports of living hardwoods infected by *Fomes annosus* in this country, although fruiting bodies have been occasionally found growing on the bark of hardwoods.

Signs and Symptoms

Fomes annosus produces fruiting bodies, conks, with a light gray to dark-grayish brown upper surface. The undersurface is creamy white, with small pores. This spore-producing undersurface becomes dark brown with age. Conks may be perennial but are usually destroyed after a relatively short time and therefore seem to be annual. Conks are irregularly shaped and range from very small buttons an eighth of an inch across up to brackets several inches across. They are formed on stumps, slash, dead trees, and at the root collar or on roots of living infected trees.

Conks are characteristically found at or even below the ground line (fig. 1), and it is often necessary to remove the duff at the base of the tree to see them. In some instances, matlike fruiting bodies are formed in the needle litter. These spore-bearing struc-

tures are irregular masses of fungus tissue and imbedded needles. Such fruiting bodies are often seen at some distance from any tree, but an attachment with a superficial root can usually be detected.

Fomes annosus conks may be abundant in some stands and absent or scarce in others. They can be easily overlooked because of their inconspicuous color and obscure location. Fresh conks are most commonly found during autumn and spring in the South, but may be present all year in the Northeast.

Pines in the earlier stages of infection can sometimes be recognized by the thin appearance of their crowns compared with nearby healthy trees. This thin appearance is due to short needles and twig internodes and loss of all but current year's needles resulting from reduced tree vigor. Infected trees often do not show these symptoms, however, since even trees with extensive root rot may have full, green crowns.

When residual pines or other conifers die within a few years after the stand was thinned, annosus root rot should be suspected. The pattern of group killing by *Fomes annosus* closely resembles that of bark beetle killing, and careful examination is necessary to distinguish between the two. Furthermore, some trees weakened by annosus root rot are attractive to certain bark beetles, and both *Fomes annosus* and bark beetles may attack the same tree. Finding conks on living trees attacked by bark beetles gives strong evidence that root rot developed first and bark beetles followed.

Fomes annosus causes a light-yellowish stringy rot. The advanced stage is typified by narrow, elongated whitish pockets that run together and reduce the wood to a spongy or stringy mass. Black spots or flecks sometimes occur in the rot pockets. The characteristics of annosus-rotted wood are seen best in broken roots of windthrown trees. Decayed roots are often shredded and stringy at the break (fig. 2), in contrast to the sharp, firmly splintered breaks of sound roots. An irregular, pinkish to dull violet stain of the sapwood in both roots and butts may indicate incipient decay.

Means of Spread

The primary means of entrance of *Fomes annosus* into a healthy stand is through infection of freshly cut stump surfaces by airborne basidiospores of the fungus. The fungus then colonizes the stump, and its root system spreads to adjacent healthy trees by means of root grafts or contacts. The fungus is unable to grow through soil directly. Further tree-to-tree spread by root contact usually results in a more or less circular infection center which may involve 50 or more trees. In the South, the entire process of infection, spread through roots, and killing of residual trees may occur within as little as 1 year following thinning.

Because of the large number of stumps through which infection may occur, *Fomes annosus* is

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Figure 2.—The typical stringy rot caused by *Fomes annosus* in a white pine.

more prevalent in thinned stands. However, the fungus can also be found in nonthinned stands. Here infection can take place on trees broken over at fusiform rust cankers near the ground line or through direct root infection of suppressed or weakened trees by spores which are washed into the soil.

Stump infection does not always lead to infection of residual trees. Apparently the fungus is unable to spread from root to root in certain soil types. In the southern Piedmont where soils are predominantly heavy clay, stump infection in thinned natural stands is common, but the fungus is seldom found on adjacent loblolly and shortleaf pine. Redcedar on these same sites is frequently attacked, however.

Damage

Fomes annosus causes damage to pines mainly through outright killing, although in white pine, there may be considerable cull from butt rot. Groups of trees or single trees scattered throughout a stand may be killed. Pines may also be windthrown because of extensive root rot (fig. 3).

A 1961 survey of 585 randomly distributed thinned pine stands, ranging from New England to Texas, has shown that the average damage from annosus root rot is fairly low at the present time. However, there was much variation in damage among specific areas within this region, from those with almost no damage to others with consistently high, often ruinous, losses. Plantations were much more severely attacked than natural stands, sometimes with as many as 30 percent of the residual trees dead or dying of annosus root rot following a thinning (fig. 4).

Loblolly pine plantations had

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Figure 3.—White pines windthrown following extensive root rot caused by *Fomes annosus*.

the highest apparent disease incidence of any species surveyed, as well as the highest average damage. Fifty-nine percent of the loblolly plots surveyed had some mortality due to annosus root rot, and 2.8 percent of all loblolly trees examined were dead or dying of this disease. The figures for slash pine plantations were slightly lower, both in regard to disease incidence and average damage.

Red pine plantations were the least affected, with less than one-third of the plots having mortality and an average of only 0.6 percent of all trees dead or dying of annosus root rot. Although survey data are not available for white pine, some thinned plantations in the southern Appalachians have been seriously damaged.

Two of the most significant findings of the survey were the very low mortality rates of natural stands as compared with plantations and the low level of damage in stands on land continually forested in comparison to those on former cropland. Survey data also showed that damage was generally greater as the number of years since the first thinnings increased and also as the number of thinnings increased. Stands on soils with coarser textured A horizons suffered more damage than those on heavier soils. Damage also tended to increase with increasing depth of the A horizon. Plots on slopes, however slight, suffered more damage than those on flat sites. Losses were also heavier in stands with deep forest litter than in those with little or no litter.

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Figure 4.—A planted stand of slash pine in South Carolina breaking up from annosus root rot following thinning.

One point stands out clearly: the highest losses occur in plantations in conjunction with thinnings. The fact that a large proportion of the tremendous acreages planted to pines in the East and South is just reaching thinning age makes this aspect especially serious.

European experience has shown higher losses in second generation plantations established on sites infested with *Fomes annosus* than in the first generation. Observations in the United States have not been made over a long enough period to determine if the same situation will be true. In the South, seedling losses after 5 years in plantations established on sites clear-cut because of heavy infestation by *Fomes annosus* have averaged only about 1 percent per year. Moreover, the infected stumps from the previous stands are rapidly decaying and seemingly will not long serve as inoculum sources. These factors would seem to indicate that *Fomes annosus* may not be an important consideration when regenerating pine plantations in the Southeast. Observations are continuing, however, until these plantations have reached commercial age in order to provide the most reliable information for forest managers.

Control

The definite relationship between thinning and damage from annosus root rot has focused attention on the possibility of control by stump treatment. A number of chemicals have been tested for use as stump protecters. Dry, granular borax has proven the most successful chemical for use

in the South and the Northeast. The borax is sprinkled liberally as a dry powder directly on the freshly cut stump surface with a saltshaker-type applicator. A 20-percent solution of urea has given satisfactory results in the Northeast. A 10-percent solution of sodium nitrite is the most commonly used chemical in eastern Canada. These materials are applied to the stump surface immediately after felling. A dye is often added to the liquid treatments to insure that all stumps are treated. However, only the dry, granular borax treatment has been registered by the U.S. Department of Agriculture for this use and is the only material recommended in the Eastern United States.

Chemical stump treatments are not recommended for use in stands where *Fomes annosus* is already present. Stump treatment under these conditions may result in more extensive colonization of stumps of already infected trees.

In the South, summer thinning can reduce the amount of stump infection and thus reduce subsequent losses in the residual stand. In the southern portions of the Gulf States and Georgia, temperatures at the stump surface often reach levels lethal to *Fomes annosus* from April through September. Formation and dispersal of basidiospores are also quite low during this period. As one goes north from this area, the safe period decreases. In northern North Carolina, only July, August, and September have low rates of stump infection. In the Northeast, stump infection probably occurs during all seasons.

Several silvicultural measures have been advocated for annosus root rot control in Europe. These include planting conifers only on sites to which they are well adapted, planting in mixtures with hardwoods and other conifers, and planting with wide spacing. Wide spacing in the South, using loblolly and slash pine, would have definite disadvantages, however, because the possibility of damage from fusiform rust increases with width of spacing. Delay of thinning and reduced numbers of thinnings may reduce the amount of annosus root rot but also will reduce economic returns.

Surveys show that natural stands, even when thinned, suffer much less damage than plantations. This suggests that stand establishment by direct seeding may reduce root rot losses on high hazard sites.

Annosus in the West

The information given in this leaflet is directly applicable only in the East. *Fomes annosus* is also important on conifers in the West, but there it may differ significantly in details of behavior.

Caution

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and ani-

mals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or when they may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Department of Agriculture, consult you county agricultural agent or State Extension specialist to be sure the intended use is still registered.

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